SVE TURN-ON CRITERIA
SVE Turn-On Criteria
Castle AFB

Introduction

There are a number of factors that can influence the decision to install and operate SVE at a site where contaminant levels exceed human health or water quality screening threshold criteria. For these sites the issue becomes: is it technically and economically feasible to install and operate an SVE system to remediate the site?

The SCOU FS selected SVE as the preferred remedial technology for these sites. However the SCOU RI/FS used a conservative screening analysis for the remedy selection which did not fully evaluate the practicality of SVE implementation on a site by site basis. The criteria below were developed to determine the technical and economical feasibility of SVE. The criteria below will be used to determine whether SVE should be implemented. This evaluation will be called a “START” and will be a primary document under the FFA.

This analysis applies to sites at Castle AFB that overlie contaminated groundwater which are addressed in the final Comprehensive Basewide Part 1 Record of Decision, signed in 1997.

The START should be conducted after all the parties agree that:
- The site has been adequately characterized;
- The risk assessment indicates that site contaminants pose a potential threat to either human health and/or the environment, including water quality.
- The SCOU FS indicated that SVE is the remedy most suited to remediate the site.

The decision to install and operate an SVE system will depend upon the analysis of the three criteria listed below. It is always technically possible to remove mass, but installing and operating an SVE system requires evaluating the tradeoff between certain monetary expenditure and uncertain environmental benefit. If the contaminant mass in the vadose zone will not reach the groundwater, remediation will not be warranted. If the contaminant concentration in the leachate entering the aquifer from the vadose zone is below the aquifer cleanup level (MCLs), the aquifer will not be unacceptably degraded further, and remediation will not be warranted. Even if the leachate concentration is above the aquifer cleanup levels (MCLs), remediation may or may not be warranted.

Several lines of evidence must be used to make this professional judgment since measuring actual leachate concentrations may be technically impractical and predicting leachate concentrations via modeling might be inaccurate.
This process represents a compromise of the various parties' policies and the results of the evaluation should be used to prepare the SCOU Part 2 Record of Decision.

Decision Criteria

The decision to install and operate SVE will be based on scientific, economic, and engineering judgment using the following criteria in sequence. The Air Force and the regulatory agencies acknowledge that there is uncertainty inherent in all of the elements used in the START, and that consensus is necessary to determine the levels of uncertainty that are acceptable in each of the elements.

I. Will the contaminant mass in the vadose zone reach the groundwater, based on either a screening level or site-specific evaluation?

To answer this question, START elements "a" through "g" must be addressed.

- If the answer is "no", then proceed with site closure.
- If the answer is "yes" or "unknown", then proceed to criterion II.

II. Will the contaminant mass in the vadose zone cause the contaminant concentrations in the leachate to exceed the aquifer cleanup level?

To answer this question, START elements "a" through "h" must be addressed.

- If the answer is "no", then proceed with site closure.
- If the answer is "yes", or "unknown", then proceed to criterion III which requires a complete START.

III. Based on an evaluation of all of the elements, is it appropriate to install and operate an SVE system at the site?

To answer this question, all START elements must be addressed.

- If the answer is "yes", then proceed with SVE system installation and operation.
- If the answer is "no" proceed with site closure negotiations.

Elements of the START

The following elements should be applied to evaluate the criteria listed above.

a. Are there any time- or land use-critical re-use issues with the site, and if so, what are they? These types of issues may preclude the need for further analysis, if SVE is required to address these concerns.

b. What is the estimated contaminant mass and areal and vertical extent of the vadose zone contaminant plume? Include contaminant isoconcentration maps and plume cross-sections to illustrate the contaminant concentrations and distribution in the subsurface.

c. Do the data indicate contaminant migration towards the groundwater? Qualitative answers to this question may be either “yes”, “no” or “unable to make a determination”. Evidence for migration towards groundwater may include such lines of evidence as: 1) increasing contaminant concentrations in onsite monitoring wells; 2) soil gas profiles from nested wells to estimate the contaminant’s propensity for migration; and 3) time-series profiles of soil gas concentrations in nested wells.

d. What is the lithology of areas that demonstrate significant soil gas concentrations of contaminants? Use site-specific information, and include as much information as possible, such as porosity, moisture content and carbon content of soil, etc.

e. What are the actual site specific infiltration and percolation rates? If site specific data are not available, what are the predicted rates?

f. Are there sufficient historical groundwater monitoring data for wells at or adjacent to the site to determine whether the vadose zone plume has or has not impacted the groundwater? (This determination may not be possible due to active groundwater extraction in the area.)

g. Is there any other site specific factors that should be considered in the evaluation such as site history and physical characteristics (e.g. organic carbon, biodegradation)? Factors to consider for this element include: 1) the nature of the release (for example: one-time spill or continued release over time?; how long ago the release occurred or ceased?; was the release to surface soil, or through a conduit to the subsurface such as a French drain, dry well, or leaking sewer line?, etc.) and 2) any site-specific physical characteristics that may enhance or retard the contaminants subsurface migration (such as unusual presence or absence of low permeability layers, high carbon content of soil, etc.).

h. What is the actual or predicted concentration and mass flux rate of leachate leaving the vadose zone? What is the concentration trend of leachate over time based on field data and modeling?

i. Qualitatively, what is the estimated SVE effectiveness of a system, based on known information and experience from similar sites?

j.   How much money, if any has been spent to date on the site's remediation?

k. What is the estimated cost to install an SVE system?

l. What are the locations and capture zones of operating groundwater extraction wells relative to the vadose zone contaminant plume? Will the existing wells effectively capture the contaminants from the site? If not, what are the additional costs to add groundwater wells?

m. What is the cost of vadose zone remediation compared to the incremental cost for additional groundwater remediation due to impacts from the site provided that the underlying contamination has not reached aquifer cleanup levels?

To implement this element, the following costs need to be calculated:

- The cost to reach the aquifer cleanup level *without* the additional impact from the site (GW_0); (SVE has been implemented)
- The cost to reach the aquifer cleanup level *with* the additional impact from the site (GW_1); (SVE has not been implemented)
- The cost of SVE installation and operation (SVE_1).

These costs can be calculated following the steps outlined below:

1. Estimate the predicted time required for the groundwater extraction system to reach aquifer cleanup level(s) in the vicinity of the site *without* additional impact from the site.
2. Estimate the monthly cost to continue operation of the groundwater extraction system in the area impacted by the site?
3. Calculate the cost to reach the aquifer cleanup level (GW_0) in the vicinity of the site *without* the additional impact from the site, because SVE will be installed and operated. (GW_0 = step 1 x step 2).
4. Using the measured residual soil gas concentrations at the site, calculate the mass of the residual contaminant in the vadose zone (same as element "b").
5. Estimate the site's potential impact to groundwater using appropriate vadose zone and groundwater fate and transport models.
6. Estimate the time to reach the groundwater aquifer cleanup level using the modeling results obtained in step 5 above.

7. Estimate the monthly cost to continue operation of the groundwater extraction system in the area impacted by the site?
8. Calculate the cost to reach the aquifer cleanup level *with* the additional impact from the site (GW_1), because SVE will not be installed and operated. (GW_1 = (step 6 x step 7) plus element l).
9. Estimate the monthly cost to operate the SVE system based on historical costs (including all costs relating to operation and shutdown).
10. Estimate the cost to install an SVE system and operate for an agreed-upon length of time that is based on site-specific conditions, such as 6 months. (SVE_1 = length of time x step 9 plus cost to install SVE i.e. element k)
11. Compare the costs of groundwater extraction *without* SVE at the site to the costs of groundwater extraction *with* SVE at the site. Is the cost of groundwater extraction without SVE at the site greater than or less than to the cost of groundwater extraction with SVE at the site? Is this cost savings to the GW system worth the expense of installing and operating an SVE system? Mathematically, this can be expressed as:

$$\text{Is } (GW_1 - GW_0) < \text{ or } > (SVE_1)\ ?$$

Implementation

The Air Force, the USEPA, and the State (DTSC and the RWQCB) will jointly decide, based on the START evaluation, whether the SVE system should or should not be installed at the site. The START should be implemented in a phased approach, with the less complex criteria (criteria I and II described above) being evaluated first. Evaluation of these two criteria may indicate that the SVE system is not necessary, without having to perform a complete START (criterion III).

There are several potential outcomes of the START evaluation. Ideally, the START would indicate unequivocally that either the SVE system would not be necessary, and all parties agree that the site could be closed, or that SVE is warranted at the site and should be installed and operated. Another potential outcome is that the START would indicate that the SVE system is not economically or technically justified, but that the site may not yet be suitable for closure, based on remaining threats to the environment or water quality. In this case, additional discussion between the parties is necessary to determine what course of action is warranted, such as alternate remedial measures or long-term monitoring.

Due to the reliance of the START on professional judgment, another outcome of the STOP is that the parties may not agree on whether the SVE system should be installed or not. If the parties cannot reach a joint resolution, any party may invoke dispute resolution.

US EPA: RPM *Original signed by:*
Lisa Hanusiak

AFBCA: RPM *Original signed by:*
Todd Lanning

CA DTSC: RPM *Original signed by:*
Rizgar Ghazi

CVRWQCB: RPM *Original signed by:*
John Russell

SVE TURN-OFF CRITERIA
SVE Termination or Optimization Process
Castle AFB

Introduction

The cleanup goal for the sites to be remediated using soil vapor extraction (SVE) is the lowest cleanup level technically and economically achievable to protect human health and the environment, including groundwater quality. The sites to be evaluated at Castle AFB overlie contaminated groundwater which is addressed in the final Comprehensive Base wide Part 1 Record of Decision, signed in 1997. The need to continue operation of an SVE system shall be evaluated at each site or group of sites. This evaluation will be called an SVE Termination or Optimization Process (STOP) and will be considered a primary document under the Federal Facilities Agreement and it may formally document site closure.

The STOP should be conducted after all the parties agree that:
- The site has been adequately characterized;
- The site does not pose an unacceptable risk to human health;
- The SVE system has been optimally designed;
- Performance monitoring indicates that the site conceptual model is accurate;
- Contaminant removal rates have stabilized and approached asymptotic levels, following one or more temporary shutdown periods; and
- The SVE system has been optimized to the greatest extent possible.

The decision to continue operation for an SVE system will depend upon the analysis of the three criteria listed below. It is always technically possible to remove more mass, but eventually whether to continued operations requires evaluating the tradeoff between certain monetary expenditure and uncertain environmental benefit. If the remaining contaminant mass in the vadose zone will not reach the groundwater, additional remediation will not be warranted. If the contaminant concentration in the leachate entering the aquifer from the vadose zone is below the aquifer cleanup level (MCLs), the aquifer will not be unacceptably degraded further. Lower cleanup levels may be achievable, but the additional cleanup required to reach them would likely not be justified. Several lines of evidence must be used to make this professional judgment since measuring actual leachate concentrations may be technically impractical and predicting leachate concentrations via modeling might be inaccurate.

This process represents a compromise of the various parties' policies and should be used as a guide in preparing the SCOU Part 2 Record of Decision.

Decision Criteria

The decision to continue SVE will be based on scientific, economic, and engineering judgment using the following criteria in sequence. The Air Force and the regulatory agencies acknowledge that there is uncertainty inherent in all of the elements used in the STOP, and that consensus is necessary to determine the levels of uncertainty that are acceptable in each of the elements.

I. Will the residual mass in the vadose zone reach the groundwater?

To answer this question, STOP elements “a” through “f” must be addressed.

- If the answer is “no”, then proceed with site closure.
- If the answer is “yes” or “unknown”, then proceed to criterion II.

II. Will the residual mass in the vadose zone cause the contaminant concentrations in the leachate to exceed the aquifer cleanup level?

To answer this question, STOP elements “a” through “g” must be addressed.

- If the answer is “no”, then proceed with site closure.
- If the answer is “yes”, or “unknown”, then proceed to criterion III which requires a complete STOP.

III. Based on an evaluation of all of the elements, is it appropriate to permanently shut-off the SVE System?

To answer this question, all STOP elements must be addressed.

- If the answer is “yes”, then shut off the SVE system and proceed with site closure.
- If the answer is “no” continue SVE operation or develop alternate remedial strategy.

Elements of the STOP

The following elements should be applied to evaluate the criteria listed above.

a. What is the estimated residual contaminant mass and areal and vertical extent of the remaining vadose zone contaminant plume? Include contaminant isoconcentration maps and plume cross-sections to illustrate the contaminant concentrations and distribution in the subsurface.

b. Do the data indicate migration towards the groundwater? Qualitative answers to this question may be either “yes”, “no” or “unable to make a determination”. Evidence for migration towards groundwater may include such lines of evidence as: 1) increasing contaminant concentrations in onsite monitoring wells; 2) pre-remediation soil gas profiles from nested wells to estimate the contaminant’s propensity for migration; and 3) post-remediation time-series profiles of soil gas concentrations in nested wells.

c. What is the lithology of areas that do and do not demonstrate rebounds in soil gas concentration? Use site-specific information, and include as much information as possible, such as porosity, moisture content and carbon content of soil, etc.

d. What are the actual site specific infiltration and percolation rates? If site specific data are not available, what are the predicted rates?

e. Are there sufficient historical groundwater monitoring data for wells at or adjacent to the site to determine whether the vadose zone plume has or has not impacted the groundwater? (This determination may not be possible due to active groundwater extraction in the area.)

f. Are there any other site specific factors that should be considered in the evaluation such as site history and physical characteristics (e.g. organic carbon, biodegradation)? Factors to consider for this element include: 1) the nature of the release (for example: one-time spill or continued release over time?; how long ago the release occurred or ceased?; was the release to surface soil, or through a conduit to the subsurface such as a French drain, dry well, or leaking sewer line?, etc.) and 2) any site-specific physical characteristics that may enhance or retard the contaminants subsurface migration (such as unusual presence or absence of low permeability layers, high carbon content of soil, etc.).

g. What is the actual or predicted concentration and mass flux rate of leachate leaving the vadose zone?

h. What was the mass removal rate prior to SVE shutdown?

i. What are the VOC concentration and cumulative mass removed expressed as a function of time?

j. How much money has been spent to date on the site’s remediation?

k. Are further enhancements to the SVE systems predicted to be technically- or cost-effective?

l. What are the locations and capture zones of operating groundwater extraction wells relative to the vadose zone contaminant plume? Will the existing wells effectively capture the contaminants from the site? If not, what are the additional costs to add groundwater wells?

m. What is the incremental cost over time of vadose zone remediation compared to the incremental cost over time for groundwater remediation provided that the underlying contamination has not reached aquifer cleanup levels? In other words, will the residual mass in the vadose zone significantly prolong the time and increase the cost to attain the aquifer cleanup level?

To implement this element, the following costs need to be calculated:

- The cost to reach the aquifer cleanup level *without* the additional impact from the site (GW_0);
- The cost to reach the aquifer cleanup level *with* the additional impact from the site (GW_1);
- The cost to reach the aquifer cleanup level *with* the additional impact from the site after an additional period of SVE operation (GW_2); and
- The cost of the additional SVE operation (SVE_1).

These costs can be calculated following the steps outlined below:

1. Estimate the predicted time required for the groundwater extraction system to reach aquifer cleanup level(s) in the vicinity of the site *without* additional impact from the site.
2. Estimate the monthly cost to continue operation of the groundwater extraction system in the area impacted by the site?
3. Calculate the cost to reach the aquifer cleanup level (GW_0) in the vicinity of the site *without* the additional impact from the site by multiplying the results of step 1 above by the results of step 2 above.   (GW_0 = step 1 x step 2).
4. Using the measured residual soil gas concentrations at the site, calculate the mass of the residual contaminant in the vadose zone (same as element "a").
5. Estimate the site's potential impact to groundwater using appropriate vadose zone and groundwater fate and transport models.
6. Estimate the time to reach the groundwater aquifer cleanup level using the modeling results obtained in step 5 above.
7. Estimate the monthly cost to continue operation of the groundwater extraction system in the area impacted by the site?
8. Calculate the cost to reach the aquifer cleanup level *with* the additional impact from the site (GW_1) by multiplying the results of step 6 by the results of step 7. (GW_1 = step 6 x step 7).
9. Estimate the monthly cost of continuing to operate the SVE system based on historical costs (including operation and shutdown periods for the site).

10. Estimate the cost to run SVE system for an agreed-upon length of time that is based on site-specific conditions, such as 6 months (SVE_1), by multiplying the agreed upon length of time by the results of step 9. (SVE_1 = length of time x step 9).
11. Estimate what the predicted residual soil gas concentrations would be if the SVE system was operated for the additional agreed-upon length of time.
12. Estimate the impact to groundwater from the site based on the results of step 11. This estimation can be conducted similarly to step 5 above.
13. Estimate the predicted time required for groundwater extraction system to reach aquifer cleanup level *with* the additional impact from the site after operation of the SVE system for an additional period of time.
14. Calculate the cost to reach the aquifer cleanup level (GW_2) *with* the additional impact from the site after operation of the SVE system for an additional period of time. This cost is calculated by multiplying the results of step 13 by the results of step 2. (GW_2 = step 13 x step 2).
15. Compare the costs of groundwater extraction *without* additional SVE at the site to the costs of groundwater extraction *with* additional SVE at the site. Is the cost of groundwater extraction without additional SVE at the site greater than or equal to the cost of groundwater extraction with SVE at the site plus the additional SVE costs.? Is this cost savings to the GW system worth the expense of continued SVE for an additional amount of time? Mathematically, this can be expressed as:

$$\text{Is} \quad (GW_1 - GW_0) \leq (SVE_1) + (GW_2 - GW_0)?$$

Implementation

The Air Force will operate the SVE system until it demonstrates that the cleanup goal set forth above has been met. The Air Force, the USEPA, and the State (DTSC and the RWQCB) will jointly decide based on the STOP evaluation whether the SVE system may be permanently shut off. The STOP should be implemented in a phased approach, with the less complex criteria (criteria I and II described above) being evaluated first. Evaluation of these two criteria may indicate that the SVE system can be shut off, without having to perform a complete STOP (criterion III).

There are several potential outcomes of the STOP evaluation. Ideally, the STOP would indicate that the SVE system could be permanently turned off, and all parties agree that the site could be closed. Another potential outcome is that the STOP would indicate that the SVE system could be permanently shut off, but that the site may not yet be suitable for closure, based on remaining threats to the environment or water quality. In this case, additional discussion between the parties is necessary to determine what course of action is warranted, such as alternate remedial measures or long-term monitoring. The STOP may also indicate that additional SVE is warranted at the site prior to permanent system shut off.

Due to the reliance of the STOP on professional judgment, another outcome of the STOP is that the parties may not agree on whether the SVE system can be shut off or not. If the parties cannot reach a joint resolution, any party may invoke dispute resolution.

US EPA: RPM	*Original signed by* Lisa Hanusiak
AFBCA: RPM	*Original signed by* Steve LaFreniere
CA DTSC: RPM	*Original signed by* Rizgar Ghazi
CVRWQCB: RPM	*Original signed by* John Russell